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(19)

(54) LAMINATE FOR PRINTED CIRCUIT BOARD

(71) We, ELECTROFOILS LIMITED, of Gloucester Road, West Chirton Industrial Estate, North Shields, in the County of Northumberland, NE29 8RQ, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to laminates and to processes for the manufacture thereof, and more particularly to laminates for use in the fabrication of printed circuit boards.

Printed circuit boards are typically electroformed copper foil laminated to an epoxy-impregnated glass cloth base, the copper forming the conductive part of the laminate and the epoxy base forming a dielectric support.

Copper foil is used extensively in electrical circuitry due mainly to its good electrical properties and to the establishment of an extensive treatment technology which enables the copper to bond strongly to suitable base materials. Such laminates are conventionally converted into printed circuits by masking the desired printed wire pattern with a photo resist and removing the unwanted areas of copper by etching. The resist is then removed to give the basic features of a printed circuit.

A disadvantage of such an arrangement is that large amounts of copper are consumed which take no part in the final circuit.

According to the present invention there is provided a laminate comprising a layer of aluminium foil having upper and lower surfaces to at least the upper surface of which is applied a layer of copper, the lower surface of the laminate being chemically or mechanically treated to improve its adhesion to a dielectric base material, whereby the laminate can be used in the production of printed circuit boards.

Preferably the laminate comprises a layer of aluminium foil to the upper surface of which is applied a layer of copper of uniform thickness and to the lower surface of which is applied a further layer of copper, said further layer being provided with a nodularised or dendritic surface of high surface area to improve adhesion to the dielectric base material.

In order to improve the adhesion of the or each copper layer to the aluminium foil, an intermediate layer of metal, conveniently zinc or a zinc-based alloy, may be applied to one or both surfaces of the aluminium foil prior to the deposition thereon of the copper layer.

A printed circuit board according to the invention comprises a laminate as detailed above, the treated surface of which is adhered to a suitable dielectric base material.

A process for the manufacture of the laminate of the invention comprises the steps of electroplating a layer of copper onto at least the upper surface of the aluminium foil, and chemically or mechanically treating the lower surface of the laminate to improve adhesion of the laminate to a dielectric base material.

Conveniently copper is electroplated onto both sides of the aluminium foil, one of the layers of copper being treated to provide a nodularised or dendritic surface thereto to improve adhesion to a dielectric base material.

In a preferred process, one or both surfaces of the aluminium foil are coated with a thin layer of metal, such as zinc or a zinc-based alloy, copper then being electroplated onto the or each coated surface of the aluminium foil.

Thus the invention provides a laminate, and a process, involving substantially less initial cost than established arrangements due to the inclusion of the cheaper aluminium foil in place of part of the copper. The resulting laminate has substantially the same properties as that of copper foil, is capable of lamination to conventional dielectric base materials in the same way as copper foil and can be subjected to established processes in the subsequent processing thereof to form printed circuits.

Heretofore aluminium has not proved a valid substitute for copper foil due to its low bondability to dielectric base materials and

its poor soldering characteristics. The encapsulation of aluminium foil with copper in the manner disclosed above, and the application of a suitable treatment to one side thereof provides a laminate which, when adhered to common base materials, gives a good bond strength, typically 8—9 lb. in^{-1}, this being measured as the force required to peel a one inch strip of the laminate at right angles from the base material. Such aluminium-copper sandwiches can be prepared in a variety of gauges in the range 10—700 microns to provide electrical properties comparable with the copper foil equivalent. In general the conductance of such aluminium-copper sandwiches is 60—80% of the conductance of copper foils of the same thickness.

EXAMPLE

Aluminium foil of 25 micron gauge was cleaned by a three minute immersion in a proprietary non-silicated soak cleaner at 60°C. The foil was then etched for one minute in a proprietary caustic soda a based solution.

After thorough rinsing with clean water the foil was immersed in a sodium zincate solution for two minutes. Such a solution can be prepared as follows:

Sodium hydroxide	230—250 g l^{-1}
Zinc oxide	60—70 g l^{-1}
Operating temperature	18—25°C

or alternatively various proprietary formulations can be utilised.

Both sides of the foil were then plated at 30 amps per square foot for five minutes with copper using a copper pyrophosphate bath to give three micron copper thickness each side. Typical of such solutions is the following formulation:

Copper as Cu^{2+}	22—38 g l^{-1}
Pyrophosphate $P_2O_7^{-4}$	150—250 g l^{-1}
Nitrate NO_3^-	5—10 g l^{-1}
Ammonia	1—3 g l^{-1}
Operating temperature 50—60°C	pH 8.6—9.2

or alternatively various other proprietary formulations can be employed.

Established techniques of treating electroformed copper foil were then employed to place a dendritic surface on one side of the copper-aluminium-copper sandwich foil.

The resultant foil was laminated to an epoxy glass cloth substrate for forty minutes in a hydraulic press at 160°C. Samples taken from this laminate possessed bond strengths in the region 8½—9 lbs. $in.^{-1}$.

Etching trials conducted using a conventional ferric chloride etchant solution showed that the copper-aluminium-copper sandwich etched cleanly to give a sharp foil edge profile with no staining of the epoxy glass cloth base.

The copper-aluminium-copper sandwich showed no tendency to delaminate or blister even on keeping it at 200°C for 24 hours. Generally the properties of the sandwich laminate were in most cases identical to those of the equivalent copper clad laminates, particularly with respect to drilling, through-hole plating, etching and soldering.

WHAT WE CLAIM IS:—

1. A laminate comprising a layer of aluminium foil having upper and lower surfaces to at least the upper surface of which is applied a layer of copper, the lower surface of the laminate being chemically or mechanically treated to improve its adhesion to a dielectric base material whereby the laminate can be used in the production of printed circuit boards.

2. A laminate as claimed in claim 1 in which a layer of copper of uniform thickness is applied to the upper surface of the aluminium foil and a further layer of copper is applied to the lower surface of said foil, said further layer being provided with a nodularised or dendritic outer surface of high surface area to improve adhesion to the dielectric base material.

3. A laminate as claimed in claim 1 or claim 2 in which an intermediate layer of metal is applied to one or both surfaces of the aluminium foil prior to the application thereto of the or each copper layer.

4. A laminate as claimed in claim 3 in which the or each intermediate layer is of zinc or of a zinc-based alloy.

5. A laminate as claimed in any one of claims 1 to 4 and of thickness within the range 10 to 700 microns.

6. A laminate as claimed in claim 5 together with claim 2 in which the aluminium foil is 25 microns thick and the copper layers are each 3 microns thick.

7. A printed circuit board comprising a laminate as claimed in any one of claims 1 to 6 the lower, treated surface of which is adhered to a dielectric base material.

8. A process for the manufacture of a laminate as claimed in any one of claims 1 to 6 comprising the steps of electroplating a layer of copper onto at least the upper surface of the aluminium foil, and chemically or mechanically treating the lower surface of the laminate to improve adhesion of the laminate to a dielectric base material.

9. A process as claimed in claim 8 in which a layer of copper of uniform thickness is electroplated onto the upper surface of the aluminium foil and a further layer of copper is electroplated onto the lower surface of said foil, said further layer of copper being

treated to provide a nodularised or dendritic outer surface thereto to improve adhesion to the dielectric base material.

10. A process as claimed in claim 8 or claim 9 in which one or both surfaces of the aluminium foil are coated with an intermediate layer of metal, a layer of copper then being electroplated onto the or each intermediate layer.

11. A process as claimed in claim 10 in which the or each intermediate layer is of zinc or a zinc-based alloy.

12. A laminate according to claim 1 and substantially as described herein.

13. A printed circuit board according to claim 7 and substantially as described herein.

14. A process for the manufacture of a laminate according to claim 8 and substantially as described herein.

15. A process for the manufacture of a printed circuit board as claimed in claim 7 and substantially as described herein.

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